Hydatidosis Prevalence, Cyst Viability and Organ Distribution and Economic Significance in Small Ruminants Slaughtered at Hashim Nur’s Export Abattoir, Debrezeit, Ethiopia

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Abstract: A cross-sectional study was conducted from October 2014 to April 2015 at Hashim Nur’s export abattoir to determine the prevalence, cyst viability and organ distribution and economic significance of small ruminant hydatidosis. 397 small ruminants comprising 209 sheep and 188 goats were examined. Post mortem inspection following standard procedures, cyst characterization and economic loss estimations were conducted. 49 (12.3%) small ruminants were harboring a single or multiple hydatid cysts. Significantly (P < 0.05) higher infection rate was observed in sheep (17.2%) than goats (6.9%). Significant variation (P < 0.05) was also observed in different age groups. Based on organ distribution in both species of infected animals, hydatid cyst was found 36.7% in lungs, 14.3% in liver, 2% in heart, 44.9% in both lungs and liver and 2% in lungs, liver and heart. Size assessment made on 120 cysts indicated 56.7% as small, 32.5% medium and 10.8% large sized cysts. 120 cysts examined, 24% were viable, 33.3% non viable, 27.5% sterile and 19.2% calcified. In sheep, 86 examined cysts for fertility and viability, 20.9% were viable, 33.7% non viable, 32.56% sterile and 12.8% calcified while in goats, 34 cysts, 17.65% were viable, 32.35% non viable, 14.7% sterile and 35.29% calcified. In the present study, the total annual economic loss due to hydatidosis was estimated to be 1, 287,179.99 (63,221 USD) Ethiopian birr. The result of this study revealed that hydatidosis pose significant economic problems. Therefore, initiation and implementation of appropriate control measures is necessary in order to alleviate its economic impact.

Key words: Abattoir • Cross-Sectional Study • Debrezeit • Economic loss • Hydatidosis • Prevalence • Small ruminant • Viability

INTRODUCTION

Sheep and goat production is an important component of agriculture and rural development program in many countries. Sheep and goats have an enormous contribution to Ethiopia’s national economy and livelihood of many Ethiopians. They play vital roles in generating income to farmers, creating job opportunities, ensuring food security, contributing to social, cultural and environmental values and sustain livelihoods. Furthermore, small ruminants are widely adapted to different climates and found in all production systems and they have lower feed requirements compared to cattle because of their small body size. This allows easy integration of small ruminants into different farming systems and economic opportunities. Taking advantage of these opportunities requires overcoming many barriers to increase productivity [1].

Despite high sheep and goat population and existing favorable environmental conditions, the current output of the country is little. This is associated with a number of complex and inter-related factors such as widespread diseases including helminthiosis, inadequate feed and nutrition, poor genetic potential of local breeds, market problem and inefficiency of livestock development services with respect to credit, extension, marketing and infrastructure [2].

In Ethiopia, significant losses result each year from inferior weight gain and condemnation of edible organs and carcass at slaughters due to helminthiosis including hydatidosis [3].

Hydatidosis is a zoonotic disease caused by larval stage of cestode parasite belonging to the genus Echinococcus, family Taeniidae [4]. It is one of the world’s most geographically wide spread zoonotic diseases [5, 6]. Metacestode (Hydatid cyst) of Echinococcus granulosus

(E. granulosus) in herbivores and humans have been recognized as the most important helminth zoonoses with great economic and public health significances. Dog and other carnivores that harbor the adult cestode in their small intestine are the definitive hosts for the parasite, while a wide range of mammalian species including domestic ungulates and man act as intermediate hosts [7].

Infection with the adult stage of E. granulosus is generally asymptomatic and non-pathogenic to the canid host. Infection with larval stage of E. granulosus can be pathogenic depending on the localization, size of the cyst and intensity of infection in the intermediate host including human [8].

The major economic impacts caused by hydatidosis in food-producing animals are losses in productivity such as reductions in carcass weight, milk production, fleece and wool value, fertility, hide value, birth rate and fecundity, delayed performance and growth, condemnation of organs especially liver and lungs, costs for destruction of infected viscera and dead animals [9-11].

The prevalence, economic and public health impact of cystic echinococcosis is higher in rural communities of developing countries where there is close contact between dogs, intermediate host species and man [10, 11]. The most common production practices that increase the prevalence and the risk of exposure of domestic animals to cystic echinococcosis are traditional systems of raising animals (Extensive or semi-extensive grazing), widespread and widespread meat inspection procedures, improper disposal of dead animals, keeping of high number of dogs, failure to treat dogs with anthelmintics, habit of feeding dogs with condemned offal and the subsequent contamination of pasture and grazing fields and grazing of animals in communal fields where stray dogs have free access [12].

In endemic areas, special attention should be paid to safe destruction of affected organs, the reduction of stray dogs and antihelmintic treatment of domestic dogs [13]. In Ethiopia, where home slaughtering of cattle, sheep and goats is still predominant and uncooked offal and carcass wastes are normally given for dogs and cats, cystic echinococcosis is an endemic disease and poses great public health and economic importance. Previous investigations showed that hydatidosis is the major cause of organ condemnation in the country [14-16] and leads to huge economic losses. It is also a disease of public health importance in Ethiopia where in Tigray Regional State nine cases of human hydatidosis were reported since 2000 [17]. Several studies have been conducted on cystic echinococcosis of cattle in different parts of Ethiopia [14, 16, 18-25]. While there are several works done in bovine hydatidosis, little attention is paid to investigate the prevalence and economic significance of hydatidosis in small ruminants in Ethiopia in general and there is no any information regarding the status of hydatidosis in small ruminants and the economic loss of the disease in Hashim Nur’s export abattoir in particular. It is also important to study the viability of hydatid cysts as it will help to understand the risk of spreading of the disease both to domestic animals and humans.

Therefore, the main objectives of this study were:

- To estimate the prevalence of hydatidosis in small ruminants slaughtered at Hashim Nur’s export abattoir
- To determine the proportion of viable cysts and fertile cysts
- To estimate the annual economic loss from organ condemnation and carcass weight loss due to hydatidosis

**MATERIALS AND METHODS**

**Study Area:** The study was conducted from October 2014 to April 2015 at Hashim Nur’s export abattoir in Debrezit town, Oromia region, Ethiopia, where thousands of sheep and goats are accessible from different districts of the region and from neighboring regions of the country for slaughter. Debrezit town is located about 45 km Southeast of Addis Ababa, the capital city of Ethiopia.

**Study Population:** The study consisted of local breeds of 209 sheep and 188 goats brought to the abattoir in slaughter. All slaughtered animals were males. The animals were purchased from merchants on weight basis and those below 13 kg and above 32 kg were rejected. The age of the slaughtered sheep and goats ranges from six month to two years. Small ruminants were categorized into two age groups, young (= 1.5 year) and adult (> 1.5 years) [26, 27].

**Study Design, Sample Size Determination and Sampling Methods:** A cross-sectional study was carried out from October, 2014 up to April, 2015, to determine the prevalence of hydatidosis, organ distribution of hydatid cysts, to assess viability of the recovered cysts and to estimate annual financial loss due to organ condemnation.
and carcass weight loss in sheep and goats slaughtered at Hashim Nur’s export abattoir. The required sample size for the study of each species of animals was determined using the formula described in Thrusfield [28] as follows:

\[ n = \frac{1.96^2 \times P_{exp} (1-P_{exp})}{d^2} \]

Where: \( n \) = required sample size
\( P_{exp} \) = expected prevalence
\( d \) = desired absolute precision.

The expected prevalence of cystic hydatidosis was taken from previous work of Daniel et al. [29] at Modjo Luna export slaughter house, which was 7.7% in sheep and 6.13% in goats. Accordingly, with 95% level of confidence and at 5% desired absolute precision, the sample size was calculated to be 109 for sheep and 88 goats. However, to increase the precision, 209 sheep and 188 goats were sampled. A systematic random sampling procedure was conducted to select individual animals for sampling in the abattoir.

Active Abattoir Survey and Laboratory Procedure

Postmortem Examination: During postmortem examination, carcass and organs of the abdominal and thoracic cavities namely liver, lung, heart, kidney and spleen were systematically inspected for the presence of hydatid cysts by applying the routine meat inspection procedures. The inspection procedure used consisted primary examination followed by a secondary examination. The primary examinations involved are visualization and palpation of organs and muscles, whereas, secondary examination involved is further incision into each organ in case where a single or multiple hydatid cysts were found. The number of hydatid cysts on each positive organ were counted and recorded. Cysts were carefully removed from organs and then transported in cool box from slaughterhouses to the Parasitology laboratory of College of Veterinary Medicine and agriculture of Addis Ababa University for study of their characteristics. By using the classification of Oostburg et al. [30] the diameter of each hydatid cyst was measured and classified as small (Diameter less than 4 cm), medium (Diameter between 4-8 cm) and large (Diameter greater than 8 cm).

Cyst Fertility and Viability Test: Individual cysts were examined grossly for degeneration. Then microscopic examination of the cyst fluid was conducted to look its characteristics. The cyst wall was penetrated using a large size needle and cut with scalpel and blade and then the content was transferred into sterile petri dish and examined for the presence of protoscolices in the hydatid fluid. After that the cyst was identified and classified as infertile (Fluid filled cyst without any protoscolices) or fertile (Fluid filled cyst with protoscolices). Further more fertile cysts were subjected to viability test. A drop of cyst fluid was placed on a microscopic glass slide and cover slip was applied and observed for the motility of flame cells activity like peristaltic movement. When it becomes doubtful for motility, a drop of 0.1% aqueous eosin solution was added and examined under Microscope for taking the dye. Live protoscolices do not take the dye whereas; the dead ones do Dalimi et al. [31].

Economic Loss Estimation: Direct and indirect losses were the basis of the estimation of the annual economic losses due to hydatidosis. Direct loss was calculated on the bases of condemned organs, whereas indirect losses were estimated on the basis of live weight loss hold by hydatidosis. Accordingly, the economic values of loss from organ condemnation were evaluated by considering the following parameters. These include, information on the mean retail market price of the organs and the average annual slaughter rate of small ruminants at Hashim Nur’s export abattoir estimated from the retrospective data of the last two years and the loss from organs condemned was calculated by using the formula described by Getaw et al. [21] as follows:

\[ \text{LOC} = (\text{NAS} \times \text{Ph} \times \text{Plu} \times \text{Cplu}) + (\text{NAS} \times \text{Ph} \times \text{Pli} \times \text{Cpli}) + (\text{NAS} \times \text{Ph} \times \text{Pli} \times \text{Cphr}) + (\text{NAS} \times \text{Ph} \times \text{Pki} \times \text{Cpki}) + (\text{NAS} \times \text{Ph} \times \text{Psp} \times \text{Cpsp}) \]

Where LOC = loss due to organ condemnation
\( \text{NAS} \) = mean number of small ruminants slaughtered annually
\( \text{Ph} \) = prevalence of hydatidosis
\( \text{Plu} \) = percent involvement of lung
\( \text{Cplu} \) = current mean retail price of lung
\( \text{Pli} \) = percent involvement of liver
\( \text{Cpli} \) = current mean retail price of liver
\( \text{Phr} \) = percent involvement of heart
\( \text{Cphr} \) = current mean retail price of heart
\( \text{Pki} \) = percent involvement of kidney
\( \text{Cpki} \) = current mean retail price of kidney
\( \text{Psp} \) = percent involvement of spleen
\( \text{Cpsp} \) = current mean retail price of spleen
Likewise, the following parameters were considered to estimate the economic loss encountered from carcass weight loss:

- Information on the retail market price of 1 kg mutton and goat meat
- The average annual slaughter rate of sheep and goats at Hasshim Nur’s export abattoir estimated from retrospective data of the last two years
- The average carcass weight loss of 2.5% due to hydatidosis [32].

Thus, the economic loss due to carcass weight loss was determined as described by using the following formula:

\[
\text{LCWL} = \text{NASs} \times \text{Phs} \times \text{CPSm} \times 2.5\% \times 14.3\,\text{kg} + \text{NASg} \times \text{Phg} \times \text{CPSGm} \times 2.5\% \times 13.5\,\text{kg}
\]

Where: LCWL = loss from carcass weight loss
2.5\% = estimated carcass weight loss due to hydatidosis
NASs = average number of sheep slaughtered
Phs = prevalence of hydatidosis in sheep
CPSm = current average price of 1 kg sheep meat
14.3 kg = average carcass weight (Dressing percentage) of sheep [32]
NASg = average number of goats slaughtered
Phg = prevalence of hydatidosis in goats
13.5 kg = average carcass weight (Dressing percentage) of goats [32]

Finally, the total economic loss was calculated by considering the loss from both organ condemnation and carcass weight loss. Thus:

\[
\text{Total loss} = \text{LOC} + \text{LCWL}
\]

**RESULTS**

**Prevalence of Hydatidosis:** In the current study, a total of 397 animals comprising 209 sheep and 188 goats slaughtered in Hashim Nur’s export abattoir in Debrezeit town were examined for the presence of hydatid cysts. Out of the total examined small ruminants, 36 (17.2%) sheep and 13 (6.9%) goats were found to harbor hydatid cysts in one or more of their internal organs (Table 1).

In this study, host species and age were considered as potential risk factors for the occurrence of hydatid cysts. Accordingly, of the total 245 young and 152 adult small ruminants examined, 11 (4.5%) young and 38 (25%) adults were found to harbor hydatid cysts in one or more of their organs. There was statistically significant difference in species and age of the animal (P < 0.05) (Table 1).

**Organ Distribution of Hydatid Cysts:** Based on organ distribution in both species of infected animals, hydatid cyst was found 36.7% in lungs, 14.3% in liver, 2% in heart, 44.9% in both lungs and liver and 2% in lungs, liver and heart. Out of 36 sheep with hydatid cysts, 14 (38.9%) harbored hydatid cysts in lungs, 5 (13.9%) in liver, 5 (13.9%) involved both lung and liver, 1 (2.8%) in heart and 1 (2.8%) in lung, liver and heart. Similarly in goats, 4 (30.8%) lungs accounted for 4 (30.8%), liver 2 (15.4%) and both lung liver 7 (53.8%) (Table 2).

**Cyst Size Characterization:** In the study, a total of 120 cysts comprising 86 cysts from sheep and 34 cysts from goats were collected from infected organs and differentiated into small, medium and large sized cysts. In sheep 68 (56.7%), 39 (32.5%), 13 (10.8%) were found to be small, medium and large cysts, respectively. In goats, 19 (55.88%), 12 (35.29%), 3 (8.823%), were small, medium and large cysts, respectively (Table 3).

**Hydatid Cyst Fertility and Viability:** From the total 120 cysts collected and examined, 24 (24%) cysts were viable, 40 (33.3%) were non viable, 33 (27.5%) were sterile and 23 (19.2%) were calcified. In sheep, a total of 86 cysts were examined to identify cyst fertility or viability and observed 18 (20.9%), 29 (33.7%), 28 (32.558 %) and 11 (12.79 %) as viable, non viable, sterile and calcified, respectively.
| Table 1: Prevalence of hydatidosis based on host species and age of animals slaughtered at Hashim Nur’s export abattoir |
|---|---|---|---|---|---|
| Risk factor | No. of examined | Number of positive | Percentage | chi-square (\(\chi^2\)) | P-value |
| Species | | | | | |
| Sheep | 209 | 36 | 17.2 | 9.724 | 0.002 |
| Goat | 188 | 13 | 6.9 | | |
| Total | 397 | 49 | 12.3 | | |
| Age | | | | | |
| Young | 245 | 11 | 4.5 | 36.472 | 0.00 |
| Adult | 152 | 38 | 25 | | |
| Total | 397 | 49 | 12.3 | | |

| Table 2: Distribution of hydatid cysts in different organs of infected sheep and goats slaughtered at Hashim Nur’s export abattoir |
|---|---|---|---|---|
| Infected organs | Lung | Liver | Heart | Liver and lung | Liver, lung and heart |
| Species | No. | % | No. | % | No. | % | No. | % |
| Sheep | | | | | | | | |
| Liver | 14 | 38.9 | 5 | 13.9 | 1 | 2.8 | 15 | 41.7 |
| Lung | 4 | 30.8 | 2 | 15.4 | 0 | 0 | 7 | 53.8 |
| Heart | 2 | 100 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 18 | 36.7 | 7 | 14.3 | 1 | 2 | 22 | 44.9 |
| Goat | | | | | | | | |
| Liver | 4 | 30.8 | 2 | 15.4 | 0 | 0 | 7 | 53.8 |
| Lung | 13 | 0 | 6 | 38.46 | 1 | 7.69 | 7 | 53.86 |
| Heart | 2 | 100 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 34 | 19 | 11 | 32.35 | 5 | 14.7 | 12 | 35.29 |
| Grand total | 52 | 25 | 18 | 35.77 | 6 | 12.3 | 34 | 66.12 |

| Table 3: Number and size of hydatid cysts in different organs of sheep and goats slaughtered at Hashim Nur’s export abattoir |
|---|---|---|---|---|
| No. and size of cyst | Small | Medium | Large |
| Species of animals | No. of cysts | No. | % | No. | % | No. | % |
| Sheep | | | | | | | | |
| Liver | 34 | 20 | 58.8 | 12 | 35.29 | 2 | 5.88 |
| Lung | 50 | 27 | 54 | 15 | 30 | 8 | 16 |
| Heart | 2 | 2 | 100 | 0 | 0 | 0 | 0 |
| Total | 86 | 49 | 56.97 | 27 | 31.39 | 10 | 11.627 |
| Goat | | | | | | | | |
| Liver | 13 | 8 | 61.53 | 4 | 30.76 | 1 | 7.69 |
| Lung | 21 | 11 | 52.38 | 8 | 38.09 | 2 | 9.52 |
| Heart | 2 | 2 | 100 | 0 | 0 | 0 | 0 |
| Total | 34 | 19 | 55.88 | 12 | 35.29 | 3 | 8.823 |
| Grand total | 120 | 68 | 56.7 | 39 | 32.56 | 13 | 10.8 |

| Table 4: Hydatid cysts fertility and viability |
|---|---|---|---|---|---|
| Cyst condition | Viable | Non viable | Sterile | Calcified |
| Species of animals | No. of cysts | No. | % | No. | % | No. | % | No. | % |
| Sheep | | | | | | | | | |
| Liver | 34 | 5 | 14.7 | 8 | 23.53 | 12 | 35.3 | 9 | 26.47 |
| Lung | 50 | 13 | 26 | 21 | 42 | 14 | 28 | 2 | 4 |
| Heart | 2 | 0 | 0 | 0 | 0 | 2 | 100 | 0 | 0 |
| Total | 86 | 18 | 20.9 | 29 | 33.7 | 28 | 32.56 | 11 | 12.8 |
| Goat | | | | | | | | | |
| Liver | 13 | 0 | 0 | 5 | 38.46 | 1 | 7.69 | 7 | 53.86 |
| Lung | 21 | 6 | 28.57 | 6 | 28.57 | 4 | 19 | 5 | 23.8 |
| Total | 34 | 6 | 17.65 | 11 | 32.35 | 5 | 14.7 | 12 | 35.29 |
| Grand total | 120 | 24 | 20 | 40 | 33.3 | 33 | 27.5 | 23 | 19.2 |
Table 5: Computed economic losses due to hydatidosis in small ruminants slaughtered at Hashim Nur’s export abattoir

<table>
<thead>
<tr>
<th>Variables</th>
<th>Computed values</th>
<th>Ethiopian birr (ETB)</th>
<th>United States dollar (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheep and goat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lung</td>
<td>347,400 x 10.32 % x 1.500 ETB</td>
<td>53,777.52</td>
<td>2,641.33</td>
</tr>
<tr>
<td>Liver</td>
<td>347,400 x 7.6 % x 8.500 ETB</td>
<td>224,420.4</td>
<td>11,022.6</td>
</tr>
<tr>
<td>Heart</td>
<td>347,400 x 0.5 % x 4 ETB</td>
<td>6,848</td>
<td>1,902.2</td>
</tr>
<tr>
<td>Sheep carcass</td>
<td>59,400 x 17.2 % x 14.3 kg x 2.5 % x 95.00 ETB</td>
<td>346,988.07</td>
<td>17,042.63</td>
</tr>
<tr>
<td>Goats carcass</td>
<td>288,000 x 6.9 % x 13.5 kg x 2.5 % x 95.00 ETB</td>
<td>637,146</td>
<td>31,294</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1,287,179.99</td>
<td>63,221</td>
</tr>
</tbody>
</table>


Viable cysts were higher in lungs (72.2%) compared to liver (27.8%) although not statistically significant (P > 0.05). However, most of cysts in the liver (35.29%) were found sterile. In goats, 6 (17.647%), 11 (32.35%), 5 (14.7%), 12 (35.29%) were identified as viable, non viable, sterile and calcified cysts, respectively. Viable cysts were found only in lungs. From a total of 13 liver cysts there was no viable cyst detected in goats. Rather calcified cysts accounted the highest proportion 7 (53.86%) of the whole cysts in liver (Table4). Generally, there was no significance difference (P > 0.05) in viability of hydatid cysts between sheep and goats (20.9% in sheep and 17.647% in goats). The proportion of viable cysts found in lungs was higher in goats (100%) than sheep 13 (72.23%) but the difference was not statistically significant (P > 0.05).

**Economic Loss Estimation**

**Economic Loss Due to Organ Condemnation:** A total of 41 lungs, 30 livers and 2 hearts were condemned due to hydatidosis with an economic loss of ETB 615, 255 and 8 respectively. This was calculated from average market price of small ruminant lungs (ETB 1.5), liver (ETB 8.5) and heart (ETB 4) and the total number of organs condemned during the study period. On the other hand, annual economic loss was determined by considering annual slaughter rate of small ruminants and prevalence of hydatidosis per lung, liver and heart. And it is calculated to be ETB 285,145.92 annually.

**Economic Loss Due to Carcass Weight Loss:** 2.5% carcass weight loss due to hydatidosis [32] was considered as the information given previously to estimate the economic loss. The computed result showed a loss of ETB 984,134.07 per annum (Table 5).

**DISCUSSION**

Hydatidosis is known to be livestock and public health important disease and for establishment of a control strategy, detailed information on local epidemiology and significance of the disease must be known. The overall prevalence of hydatidosis in sheep and goats slaughtered at Hashim Nur’s export abattoir in the present study was 12.3%. This finding is lower when compared to that of Kebebe et al. [22] in small ruminants slaughtered at Addis Ababa abattoir with an overall prevalence of 18.4%. The most probable reason is that most of the slaughtered animals in the current study were young. It is a well established fact that prevalence of hydatidosis increases with the age of animal [33]. Moreover, there might be also a sample size difference. In the other hand the present finding is higher than that of Ermias et al. [34] (9.7 %) and Helina et al. [35] (8.6 %) done at Addis Ababa abattoir. This higher prevalence in the current study might be due to close association of dogs and small ruminants and lack of public awareness about hydatidosis where the study animals brought.

In the current study, the prevalence of hydatidosis in sheep was found to be 17.2% and this value is comparable with 16% in Addis Abeba abattoir by Kebebe et al. [22]. However, it is lower than 22.2% in Nekemte, 29.3%, in adama and 29.7% in Jimma by Kumsa [18], Getaw et al. [21] and Bersissa and Ahmedin [36] respectively. Abiyot et al. [37] observed lower hydatid cyst infection (8.05%) in Modjo modern export abattoir, Ethiopia. In the other hand the prevalence in goats in the present study was 6.9% and this value is comparable with the study of Getaw et al. [21] (6.7%) at Adama municipal abattoir, Ethiopia. In contrast, Bersissa and Ahmedin [36] in Jimma and Kebebe et al.[22] in Addis Ababa reported a prevalence rate of 24.8% and 15.9% respectively, which are higher than the present finding (6.9%). A possible reason for the difference in the prevalence of hydatidosis might be due to the contact between large numbers of stray dogs with the herd of sheep and goats. Dogs, which are the primary factor for the disease transmission, are used as guards for herds and routinely fed with uncooked offal which deemed unfit for human consumption [21]. The other possible reason for the variation in the prevalence rate in
different regions may be attributed mainly to strain difference of *E. granulosus* that exists in different geographical situations. Moreover, other factors like difference in culture, awareness and social activities in different regions may contribute to these variations [17].

In this study, the prevalence of cystic echinococcosis in sheep (17.2%) was higher than in goats (6.9%). This may be due to the difference in feeding habits. It is a well established fact that goats feed mainly by browsing than grazing whereas, sheep graze close to the rot of grasses on pastures contaminated with oncospheres of *E. granulosus* [18]. This observation agrees with the earlier report by Kebebe et al. [22]. This difference might also be as a result of the involvement of different strains of *E. granulosus*. There is an evidence that indicates the existence of a number of strains of *E. granulosus*, which differ morphologically and biochemically. These include strains, which utilize sheep/dog, horse/dog, Camel/dog, pig/dog, buffalo/dog, goat/dog, cattle/ dog and man/dog cycles [38].

In this study, an attempt was made to assess the relationship between age and cyst infection. The result indicated that there was a significant difference (P < 0.05) in rate of infection between age categories. Adult animals were found to have high cyst infection. This is most probably due to the fact that adult animals are exposed to infection for a long period of time, which also provides the parasite sufficient time to develop to a size that is detectable on meat inspection [39] reported a prevalence of 3.87% and 29.78% in young (< 3years) and adult animals (> 3years) respectively, which is similar with the present finding.

In the present study it was established that hydatid cysts occur predominantly in the lungs and liver of infected animals. This could be due to the fact that lungs and liver possess great numbers of capillaries sites encountered by the migrating *Echinococcus* oncospheres (Hexacanth embryo) that take the portal vein route and primarily negotiate the hepatic and pulmonary filtering system sequentially before any other peripheral organ is involved. This finding is in line with the observations of other previous workers like [7, 40] who obtained similar results in Ethiopia.

From single to four cysts were encountered from a single lung of animals. Such variations in cyst abundance are mainly due to the spatial distribution and the infectivity of *E. granulosus* eggs and the susceptibility and defense capability of the host. The proportion of large and medium sized cysts was higher in the lungs than in the liver. This may be due to the relatively softer consistency of the lungs, which allows easy growth of cysts. Similar findings were obtained by various workers in different regions of Ethiopia [41-43]. Similarly, in the rarer sites such as the abdominal cavity, where unrestricted growth is possible, the hydatid cyst may attain very large size containing several litters of fluid [44].

With regard to cyst fertility, fertile cysts were higher in the lungs than in the liver both in goats and sheep. This might be due to the softer consistency of lung tissue that allows easier development of the cyst. This finding is in agreement with that of Kebede et al. [17] and Dalimi et al. [31] who concluded that the fertility rates of hepatic cysts were lower than that of pulmonary ones.

In this study, the fertility rate of hydatid cyst was higher in sheep than in goats. This provides reliable indicators of the importance of sheep as a potential source of infection than goats for the final hosts. This variation could be attributed to strain differences in traits such as host preference, development rate and infectivity. Cysts, depending on the geographical situation, host, site, size and type of cyst may have different rates of fertility [10]. The proportions of viable protoscoleces from fertile cysts of sheep (38.3 %) and goats (35.3 %) in the present study may be related to the difference in immunological response in different hosts. Similarly, Fikre [42] and Yemane [45] have got higher fertility rate of hydatid cysts in sheep than goats.

The percentage of calcified cysts was found higher in livers than in lungs in both sheep and goats. This may be associated with the relatively higher reticuloendothelial cell and abundant connective tissue reaction of the organ, which encapsulates the cyst within a fibrous wall.

In this study significant economic loss was registered due to hydatidosis with an estimated loss of 1, 287,179.99 ETB (63,221 USD). Different amount of economic losses due to hydatidosis in sheep and goats were also reported from different parts of the country. For example, 17,100.98 ETB in Haramaya municipal abattoir by Yeshiwork [46], 10,898.64 ETB in East Shoa by Yemane [45] and 14,755.34 ETB in Nekemte by Bersissa [47] were reported. According to Getaw et al. [21], the total annual economic loss incurred due to hydatidosis in ruminants slaughtered at Adama municipal abattoir was estimated to be to 52,828 ETB (5,869.8 USD). In Jimma, Bersissa and Ahmedin [36] also reported a direct financial loss of 19,190 ETB from condemnation of lungs and liver. The difference in economic losses could be due to the variation in the prevalence of the disease, mean annual slaughter rate in different abattoirs and variation in retail market price of organs and meat.
CONCLUSION

Hydatidosis is prevalent and causes considerable economic loss in sheep and goats slaughtered at Hashim Nur’s export abattoir. The prevalence rate of hydatidosis was high in sheep compared to goats and in both species lungs were the most frequently affected organ by hydatid cyst followed by liver. The difference in prevalence is highly significant between young and adult. The fertility rate and viability of hydatid cyst was higher in sheep than in goats. Viable cysts were higher in lungs compared to liver in both sheep and goats.

Based on the above conclusions the following recommendations are forwarded:

- Public awareness and education programmes should be created on the transmission cycle of hydatidosis.
- Revision and upgrading of meat inspection legislations and procedures should be conducted.
- Establishment of adequate slaughter houses and application of thorough meat inspection procedures should be taken.
- Promoting the establishment of intensive farms should be encouraged to reduce the exposure of small ruminants to hydatidosis.
- Proper condemnation of the infected offal and effective control measures need to be introduced to reduce the stray dog population.

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REFERENCES


